III.E.9 Low-Cost, High-Temperature Recuperators for SOFC Fabricated from Machinable Ceramic (Ti_3AlC_2)

Objectives

- Verify corrosion resistance of machinable ceramic for SOFC recuperator application.
- Design and fabricate a proof-of-concept recuperator core.
- Demonstrate proof-of-concept recuperator core performance and durability when exposed to SOFC recuperator operating conditions.

Accomplishments

This project has been selected for award of a Phase I SBIR grant.

Introduction

Achieving low system cost for SOFC technology requires novel approaches to the materials used for the air preheat recuperator. The recuperator is needed to heat up large quantities of air (~6 to 7 times in excess of stoichiometric requirements). The cost of existing recuperator designs is high primarily because of the high cost of the materials used. Heat resistant metal alloys tolerant of gas temperatures up to 1,000°C such as the Inconel-series metal alloys are typically used. These alloys are expensive, difficult to machine, and cannot be cast into near-net shape, leading to bulky heat exchanger designs. Further, the recuperator surfaces exposed to air need to be aluminized to prevent chromia poisoning of the cathode. The aluminizing further increases cost.

A new class of machinable, easily fabricated ceramic materials with good high temperature properties has been discovered (see Figure 1). Examples of this material class that are particularly well suited for the recuperator application are Ti_3SiC_2 and Ti_3AlC_2. The high temperature mechanical and thermal properties, the high temperature stability, and the manufacturability make this class of ceramics an ideal material for high temperature recuperators, specifically for air preheaters for SOFC.

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Approach

TIAX will develop an approach for fabrication of SOFC recuperators with machinable ceramic using crossflow and counterflow plate-fin heat exchanger configurations. During the Phase I work, we will first verify the machinable ceramic's corrosion resistance when exposed to SOFC exhaust products at 1,000°C operating temperature. In addition, a small proof-of-concept recuperator core will be designed, fabricated, and tested. Testing will include heat transfer performance testing, maximum-temperature endurance testing, and thermal cycling. This work will establish the feasibility of the material for the intended use in a SOFC recuperator.

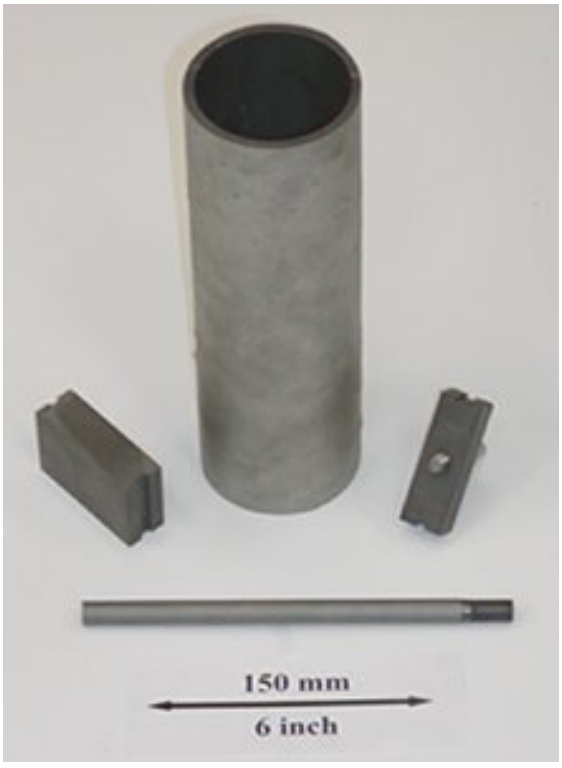

FIGURE 1. Examples of Fabricated and Machined Ti_3SiC_2 and Ti_3AlC_2